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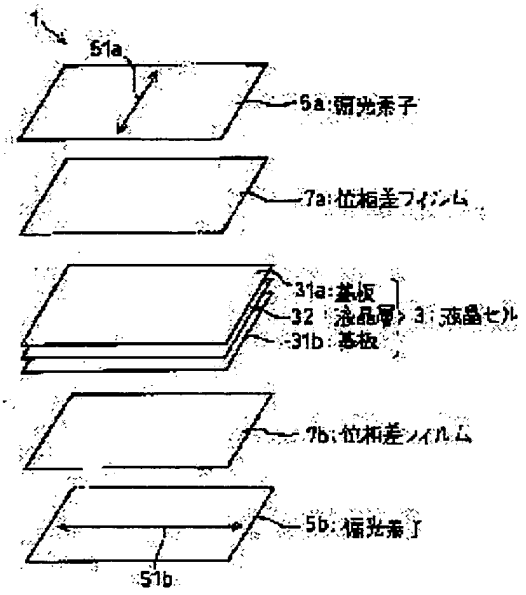
(54) LIQUID CRYSTAL DISPLAY DEVICE AND METHOD AND DEVICE FOR SELECTING RETARDATION

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a liquid crystal display device of a perpendicular alignment mode in which the retardation between an optical retardation film and a liquid crystal layer is controlled to the optimum value, and to provide a method and an operational device to derive the optimal retardation range by a small number pf process.

SOLUTION: When the retardation of the liquid crystal cell 3 and the retardation of the optical retardation films 7a, 7b are to be determined into a proper combination in the liquid crystal display device 1, one combination is first selected, and the voltage-transmittance curve Ta in the direction (A) which is the largest angle in the desired viewing angle range and makes 45° angle with the absorption axes 51a, 51b of the polarizing elements 5a, 5b in the plane direction is derived. Further, a peak voltage in the curve Ta is defined as a white voltage Vw. Then the display quality such as contrast in the direction (A) is evaluated based on the white voltage Vw to derive the optimum combination.



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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The liquid crystal layer containing the liquid crystal which a perpendicular orientation film is applied to a substrate front face, and has a negative dielectric constant anisotropy, In the liquid crystal display which carries out a black display to the state where have the polarizing element allotted to the both sides of a liquid crystal layer, and the phase contrast film arranged among both polarizing elements, and the liquid crystal molecule is carrying out orientation perpendicularly to the substrate in general The sum total Rth of the retardation of the thickness direction of the above-mentioned phase contrast film, The retardation Rlc of the above-mentioned liquid crystal layer is Rth. <= Rlc + 150nmRth >= 1.25, Rlc - 262.5nmRlc >= 75nm and Rth >= Liquid crystal display characterized by filling 30nm.

[Claim 2] The sum total Rth of the retardation of the thickness direction of the above-mentioned phase contrast film and the retardation Rlc of the above-mentioned liquid crystal layer are Rth. <= 1.5, Rlc + 80nm and Rlc >= Liquid crystal display according to claim 1 characterized by filling 155nm.
[Claim 3] The liquid crystal layer containing the liquid crystal which a perpendicular orientation film is applied to a substrate front face, and has a negative dielectric constant anisotropy, In the liquid crystal display which carries out a black display to the state where have the polarizing element allotted to the both sides of a liquid crystal layer, and the phase contrast film arranged among both polarizing elements, and the liquid crystal molecule is carrying out orientation perpendicularly to the substrate in general The sum total Rth of the retardation of the thickness direction of the above-mentioned phase contrast film and the retardation Rlc of the above-mentioned liquid crystal layer are Rth. <= 1.5, Rlc + 80nm and Rlc >= Liquid crystal display characterized by filling 155nm.
[Claim 4] The sum total Rth of the retardation of the thickness direction of the above-mentioned phase contrast film is Rth. <= 250nm and Rlc >= Liquid crystal display according to claim 1, 2, or 3 characterized by filling 30nm.
[Claim 5] The liquid crystal display according to claim 1, 2, 3, or 4 characterized by establishing two or more fields where the response directions of a liquid crystal molecule differ for every pixel in the above-mentioned liquid crystal layer.
[Claim 6] The liquid crystal display according to claim 1, 2, 3, or 4 characterized by setting the response direction of a liquid crystal molecule as an axial symmetry in general for every pixel in the above-mentioned liquid crystal layer.
[Claim 7] The shaft of the above-mentioned axial-symmetry orientation is a liquid crystal display according to claim 6 characterized by preparing more than one for every pixel.
[Claim 8] The retardation selection method of a liquid crystal display of carrying out a black display to the state where a perpendicular orientation film is applied to the substrate front face characterized by providing the following, have the liquid crystal layer containing the liquid crystal which has a negative dielectric constant anisotropy, the polarizing element allotted to the both sides of a liquid crystal layer, and the phase contrast film arranged among both polarizing elements, and the liquid crystal molecule is carrying out orientation perpendicularly to the substrate in general. In case the combination of the retardation of the above-mentioned liquid crystal layer and the retardation of a phase contrast film is derived, it is desired display grace. The conditioning process which sets up an angle of visibility to secure the display grace concerned. The applied-voltage determination process of drawing the voltage-permeability property of the above-mentioned liquid crystal display in the 1st direction in which it inclines most from [of the above-mentioned substrate] a normal among the above-mentioned angles of visibility, and the direction within a field of the above-mentioned substrate makes the absorption shaft of the above-mentioned polarizing element, and the angle of 45 degrees, and determining the maximum point as white voltage. The judgment process which judges whether display grace satisfies the display grace of the above-mentioned request based on the determined white voltage.
[Claim 9] The display grace set up at the above-mentioned conditioning process is the retardation selection method of the liquid crystal display according to claim 8 characterized by what contrast and the above-mentioned minimum

contrast are compared, and is judged. [in / the 1st direction of the above / it is the minimum contrast which should be maintained within the above-mentioned angle of visibility, and / in the above-mentioned judgment process]
[Claim 10] The display grace set up at the above-mentioned conditioning process is the retardation selection method of the liquid crystal display according to claim 8 or 9 characterized by being the permeability at the time of the white voltage impression in the direction of a transverse plane of the above-mentioned substrate.
[Claim 11] Furthermore, it is based on the above-mentioned white voltage and the voltage-permeability property in the direction of a transverse plane of the above-mentioned substrate. The display grace set up at the above-mentioned conditioning process including the middle gradation voltage determination process of determining the applied voltage of middle gradation The retardation selection method of the liquid crystal display according to claim 8, 9, or 10 characterized by being the grade of similarity in each gradation voltage-permeability property in the above-mentioned transverse-plane direction, and each gradation voltage-permeability property in the 1st direction of the above.
[Claim 12] Retardation selecting arrangement of a liquid crystal display which carries out a black display to the state where a perpendicular orientation film is applied to the substrate front face characterized by providing the following, have the liquid crystal layer containing the liquid crystal which has a negative dielectric constant anisotropy, the polarizing element allotted to the both sides of a liquid crystal layer, and the phase contrast film arranged among both polarizing elements, and the liquid crystal molecule is carrying out orientation perpendicularly to the substrate in general. In case the combination of the retardation of the above-mentioned liquid crystal layer and the retardation of a phase contrast film is derived, it is desired display grace. A conditioning means to set up an angle of visibility to secure the display grace concerned. An applied-voltage determination means to draw the voltage-permeability property of the above-mentioned liquid crystal display in the 1st direction in which it inclines most from [of the above-mentioned substrate] a normal among the above-mentioned angles of visibility, and the direction within a field of the above-mentioned substrate makes the absorption shaft of the above-mentioned polarizing element, and the angle of 45 degrees, and to determine the maximum point as white voltage. A judgment means to judge whether display grace satisfies the display grace of the above-mentioned request based on the determined white voltage.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates the liquid crystal display with which the retardation of a phase contrast film and a liquid crystal layer was set as the optimal value, and the range concerned about the liquid crystal display in perpendicular orientation mode to the retardation selection method and equipment which can be derived by few time and effort.
[0002]
[Description of the Prior Art] The liquid crystal display which is easy to cut down power consumption and a size compared with CRT has spread widely as a screen of a word processor, a computer, or television. VA which combined the negative-mold liquid crystal material which the contrast of a display is high compared with TN method, and has a negative dielectric constant anisotropy as a quick method of a speed of response here in recent years, and the vertical orientation film (Verticically Aligned) The liquid crystal display of a method attracts attention.
[0003] A liquid crystal molecule inclines at the time of voltage impression, and the liquid crystal display of the VA method concerned becomes a substrate with an abbreviation horizontal, shows big form birefringence and becomes a white display while it is not the rotatory-polarization mode of a liquid crystal molecule, and the liquid crystal molecule which carried out orientation perpendicularly hardly shows form birefringence but becomes a black display in the state of no voltage impressing using birefringence mode as indicated by JP,11-258605,A.
[0004]
[Problem(s) to be Solved by the Invention] However, in the liquid crystal display of the above-mentioned composition, in order to operate in birefringence mode, expansion of an angle of visibility is difficult and a phase contrast film is prepared in many cases. However, in order to expand an angle of visibility, in spite of setting the retardation of a phase contrast film, and the retardation of a liquid crystal layer as a suitable value, since the derivation method of a suitable combination of retardation is not established, many computational complexity, measurement sizes, etc. will be needed. Consequently, the problem that it is difficult to realize the liquid crystal display set as the suitable value is produced.
[0005] Specifically, when measuring display grace in an experiment, it is necessary to create a liquid crystal display, and takes time and effort. On the other hand, since it is necessary to compute an orientation state by calculating the equilibrium of a liquid crystal molecule even if it is the case where it computes in a simulation, computational complexity will become large. Therefore, in order to derive a suitable combination, supposing it sets up retardation at random and repeats experiment/display grace evaluation in arbitrary directions, it will take very big time and effort.
[0006] Moreover, in a liquid crystal display, although permeability changes with applied voltage, a voltage-permeability curve is not not only alignment, but changes with viewing angles a lot. Therefore, a viewing-angle property changes also with setup of the applied voltage at the time of a white display. Consequently, time and effort required for still more suitable retardation selection will increase.
[0007] this invention is made in view of the above-mentioned trouble, and the purpose has the retardation of a phase contrast film and a liquid crystal layer in offering the retardation selection method and equipment which can be derived by few time and effort in the liquid crystal display in perpendicular orientation mode in the liquid crystal display set as the optimal value, and the range concerned.
[0008]
[Means for Solving the Problem] The liquid crystal layer containing the liquid crystal which a perpendicular orientation film is applied to a substrate front face, and has a negative dielectric constant anisotropy in order that the liquid crystal display concerning this invention may solve the above-mentioned technical problem, In the liquid crystal display which carries out a black display to the state where have the polarizing element allotted to the both sides of a liquid crystal layer, and the phase contrast film arranged among both polarizing elements, and the liquid crystal

molecule is carrying out orientation perpendicularly to the substrate in general The sum total Rth of the retardation of the thickness direction of the above-mentioned phase contrast film, The retardation Rlc of the above-mentioned liquid crystal layer is Rth. <= Rlc + 150nm, Rth >= 1.25, Rlc - 262.5nm, Rlc >= 75nm and Rth >= It is characterized by filling 30nm.

[0009] With the above-mentioned composition, the upper limit and the minimum are set up about the retardation combination of a liquid crystal layer and a phase contrast film, and five or more contrast can be maintained, without carrying out tone reversal in the viewing-angle range at large [to a direction] which inclined 60 degrees from [of a substrate] the normal, if it is set as the range concerned. Consequently, the good liquid crystal display of the display grace of a slanting viewing angle is certainly realizable.

[0010] For the liquid crystal display of the above-mentioned composition, the sum total Rth of the retardation of the thickness direction of the above-mentioned phase contrast film and the retardation Rlc of the above-mentioned liquid crystal layer are Rth<= further. 1.5, Rlc + 80nm and Rlc >= It is more desirable to fill 155nm.

[0011] According to the composition concerned, the permeability of the direction of a transverse plane of a liquid crystal display can be kept at 0.2 or more times of the permeability of air. Consequently, the display grace of a slanting viewing angle can realize a good liquid crystal display certainly, without spoiling the brightness of the direction of a transverse plane, and contrast.

[0012] Moreover, the liquid crystal layer containing the liquid crystal which a perpendicular orientation film is applied to a substrate front face, and has a negative dielectric constant anisotropy in order that the liquid crystal display concerning this invention may solve the above-mentioned technical problem, In the liquid crystal display which carries out a black display to the state where have the polarizing element allotted to the both sides of a liquid crystal layer, and the phase contrast film arranged among both polarizing elements, and the liquid crystal molecule is carrying out orientation perpendicularly to the substrate in general The sum total Rth of the retardation of the thickness direction of the above-mentioned phase contrast film and the retardation Rlc of the above-mentioned liquid crystal layer are Rth. <= 1.5andRlc+ 80nm and Rlc >= It is characterized by filling 155nm.

[0013] Moreover, the permeability of the direction of a transverse plane can be kept at 0.2 or more times of the permeability of air, without carrying out tone reversal of it in the viewing-angle range at large [to a direction] which inclined 60 degrees from [of a substrate] the normal, if the upper limit and the minimum are set up about the retardation combination of a liquid crystal layer and a phase contrast film and the above-mentioned composition is also set as the range concerned. Consequently, the display grace of a slanting viewing angle can realize a good liquid crystal display certainly, without spoiling the brightness of the direction of a transverse plane, and contrast.

[0014] Furthermore, for the liquid crystal display of each above-mentioned composition, the sum total Rth of the retardation of the thickness direction of the above-mentioned phase contrast film is Rth. <= 250nm and Rlc >= It is more desirable to fill 30nm.

[0015] According to the composition concerned, in the viewing-angle range at large [to a direction] which inclined 60 degrees from [of a substrate] the normal, the voltage-permeability property which was similar to the voltage-permeability property in the direction of a transverse plane in general can be maintained. Consequently, even if it sees the picture displayed on a liquid crystal display from which direction of the above-mentioned viewing-angle range, the ratio of the luminosity between each gradation becomes the in general same value, and can realize a liquid crystal display with the good gradation property of a slanting viewing angle.

[0016] Moreover, in the liquid crystal display of each above-mentioned composition, two or more fields where the response directions of a liquid crystal molecule differ for every pixel may be established in the above-mentioned liquid crystal layer. Furthermore, in the above-mentioned liquid crystal layer, the response direction of a liquid crystal molecule may be set in general as the axial symmetry for every pixel. In addition, two or more shafts of the above-mentioned axial-symmetry orientation may be established for every pixel. According to these composition, since a mutual field carries out optical compensation and it suits by orientation division of a pixel, the display grace of a slanting viewing angle can realize a good liquid crystal display more.

[0017] On the other hand, the retardation selection method of the liquid crystal display concerning this invention The liquid crystal layer containing the liquid crystal which a perpendicular orientation film is applied to a substrate front face, and has a negative dielectric constant anisotropy, It has the polarizing element allotted to the both sides of a liquid crystal layer, and the phase contrast film arranged among both polarizing elements. In order that a liquid crystal molecule may be the retardation selection method of a liquid crystal display of carrying out a black display to the state where orientation is perpendicularly carried out in general to the substrate and may solve the above-mentioned technical problem In case the combination of the retardation of the above-mentioned liquid crystal layer and the retardation of a phase contrast film is derived, desired display grace, The conditioning process which sets up an angle of visibility to secure the display grace concerned, and the inside of the above-mentioned angle of visibility, Incline

most from [of the above-mentioned substrate] a normal, and the direction within a field of the above-mentioned substrate draws the voltage-permeability property of the above-mentioned liquid crystal display in the 1st direction which makes the absorption shaft of the above-mentioned polarizing element, and the angle of 45 degrees. It is characterized by including the applied-voltage determination process of determining the maximum point as white voltage, and the judgment process which judges whether display grace satisfies the display grace of the above-mentioned request based on the determined white voltage. In addition, for example, the properties of a liquid crystal display, such as a voltage-permeability property, may be computed by the simulation, and it may experiment and they may be drawn.

[0018] With the above-mentioned composition, based on a desired angle of visibility and the absorption shaft orientation of a polarizing element, display grace determines the 1st worst direction and determines the maximal value of the voltage-permeability curve of the 1st direction concerned as white voltage. Thereby, predetermined voltage can be determined as white voltage, or white voltage can be most highly set up compared with the case where white voltage is determined based on the permeability of other directions etc., in the range which does not carry out tone reversal within the above-mentioned angle of visibility by fewer computational complexity or a fewer measurand. Consequently, tone reversal is not carried out within an angle of visibility, but the combination of retardation with the moreover highest display grace can be derived by comparatively few time and effort.

[0019] Moreover, in the above-mentioned composition, the display grace set up at the above-mentioned conditioning process is the minimum contrast which should be maintained within the above-mentioned angle of visibility, and the above-mentioned judgment process may compare and judge the contrast and the above-mentioned minimum contrast in the 1st direction of the above.

[0020] According to the composition concerned, the contrast of the 1st direction where display grace is the worst can derive the combination with which desired conditions are filled within the above-mentioned angle of visibility. Therefore, the retardation combination which can secure the above-mentioned minimum contrast at least can be derived by comparatively few time and effort throughout [above-mentioned] the inside of an angle of visibility.

[0021] Furthermore, in each above-mentioned composition, the display grace set up at the above-mentioned conditioning process may be the permeability at the time of the white voltage impression in the direction of a transverse plane of the above-mentioned substrate. According to the composition concerned, the retardation combination for the brightness and contrast of the direction of a transverse plane realizing a good liquid crystal display can be derived.

[0022] Moreover, the display grace further set up at the above-mentioned conditioning process including the middle gradation voltage determination process of determining the applied voltage of middle gradation, based on the above-mentioned white voltage and the voltage-permeability property in the direction of a transverse plane of the above-mentioned substrate may be the grade of similarity in each gradation voltage-permeability property in the above-mentioned transverse-plane direction, and each gradation voltage-permeability property in the 1st direction of the above in each above-mentioned composition.

[0023] With the above-mentioned composition, after determining middle gradation voltage based on the white voltage decided at the above-mentioned applied-voltage determination process, the grade of similarity of the 1st direction, the direction of a transverse plane, and a gradation voltage-permeability property is judged. Consequently, even if it is the case where the picture displayed on a liquid crystal display is seen from which direction of [in the above-mentioned angle of visibility], retardation combination to which the ratio of the luminosity between each gradation is similar can be derived by comparatively few time and effort.

[0024] Moreover, the retardation selecting arrangement of the liquid crystal display concerning this invention The liquid crystal layer containing the liquid crystal which a perpendicular orientation film is applied to a substrate front face, and has a negative dielectric constant anisotropy, It has the polarizing element allotted to the both sides of a liquid crystal layer, and the phase contrast film arranged among both polarizing elements. In order that a liquid crystal molecule may be the retardation selecting arrangement of a liquid crystal display which carries out a black display to the state where orientation is perpendicularly carried out in general to the substrate and may solve the above-mentioned technical problem In case the combination of the retardation of the above-mentioned liquid crystal layer and the retardation of a phase contrast film is derived, desired display grace, A conditioning means to set up an angle of visibility to secure the display grace concerned, and the inside of the above-mentioned angle of visibility, Incline most from [of the above-mentioned substrate] a normal, and the direction within a field of the above-mentioned substrate draws the voltage-permeability property of the above-mentioned liquid crystal display in the 1st direction which makes the absorption shaft of the above-mentioned polarizing element, and the angle of 45 degrees. It is characterized by having an applied-voltage determination means to determine the maximum point as white voltage, and a judgment means to judge whether display grace satisfies the display grace of the above-mentioned request based on the

determined white voltage. In addition, by the simulation, the above-mentioned applied-voltage determination means and a judgment means may compute the property of a liquid crystal display, and may draw the property of a liquid crystal display based on the input of an experimental result.

[0025] Since the above-mentioned retardation selecting arrangement derives the combination of the retardation of a liquid crystal layer, and the retardation of a phase contrast film by the above-mentioned retardation selection method, predetermined voltage can be determined as white voltage, or compared with the case where white voltage is determined based on the permeability of other directions etc., it is fewer computational complexity or a measurand, and can set up white voltage most highly in the range which does not carry out tone reversal within the above-mentioned angle of visibility, for example. Consequently, tone reversal is not carried out within an angle of visibility, but the combination of retardation with the moreover highest display grace can be derived by comparatively few time and effort.

[0026]

[Embodiments of the Invention] [1st operation gestalt] It is as follows when 1 operation gestalt of this invention is explained based on drawing 1 or drawing 7 . That is, the liquid crystal display 1 concerning this operation gestalt is equipped with phase contrast film 7a and 7b of the negative film arranged, respectively between the liquid crystal cell 3 containing the liquid crystal layer 32 pinched by substrate 31a and 31b, polarizing-element 5a and 5b which were allotted to the both sides of a liquid crystal cell 3, and between a liquid crystal cell 3 and polarizing-element 5a and a liquid crystal cell 3 and polarizing-element 5b as shown in drawing 1 .

[0027] The direction of absorption shaft 51a and 51b of the above-mentioned both polarizing-elements 5a and 5b is set up so that it may intersect perpendicularly. Moreover, the sense (field inboard) of the lagging axis of phase contrast film 7a and 7b is set up so that it may become 45 degrees to absorption shaft 51a and 51of polarizing-element 5a and 5b b.

[0028] The TFT substrate which the above-mentioned liquid crystal cell 3 is a liquid crystal cell of a perpendicular orientation (VA) method, and, on the other hand, arranged TFT (TFT) and the pixel electrode 33 (after-mentioned) in the shape of a matrix (substrate 31a and 31b on the other hand), While printing the perpendicular orientation film which is not illustrated to the light-filter (CF) substrate (another side of substrate 31a and 31b) which has a counterelectrode and sticking both substrates 31a and 31b on it, the liquid crystal layer 32 which has a negative dielectric constant anisotropy is enclosed and created in the gap of both substrates 31a and 31b. Thereby, at the time of no voltage impressing, while the liquid crystal molecule of the liquid crystal layer 32 carries out orientation to an abbreviation perpendicular, at the time of voltage impression, a liquid crystal molecule inclines and orientation can be carried out horizontally. Furthermore, in the liquid crystal cell 3 concerning this operation gestalt, as shown in drawing 2 , the abbreviation square drill-like salient 34 is formed in each pixel electrode 33 prepared in one substrate 31a (31b). Orientation of the above-mentioned salient 34 is carried out so that it may be set up so that the direction of each slant face and the direction which projected the direction more perpendicular to each slant face in a detail into the field of substrate 31a and 32a may make absorption shaft 51a and 51b, and the angle of 45 degrees of the above-mentioned polarizing-element 5a and 5b, and a liquid crystal molecule may become perpendicular to each slant face near the salient 34. In addition, the electric field of the portion of salient 34 incline in the direction which becomes parallel to the slant face of salient 34 at the time of voltage impression. In case a liquid crystal molecule inclines these results at the time of voltage impression, in field inboard, it is easy to incline to a direction 45 degrees to absorption shaft 51a and 51b. In addition, on the above-mentioned TFT substrate, each above-mentioned salient 34 applies a light-sensitive nature resin, and can form it by processing it at a photo lithography process.

[0029] In the liquid crystal display 1 of the above-mentioned composition, at the time of no voltage impressing, orientation of the liquid crystal molecule of the liquid crystal layer 32 is carried out to an abbreviation perpendicular to the front face of substrate 31a (31a) except for an about 34-salient a small number of molecule, and the liquid crystal layer 32 has almost no form birefringence. Consequently, a good black display is obtained. On the other hand, when an electrode is impressed to the pixel electrode 33, the liquid crystal molecule of the pixel corresponding to the pixel electrode 33 inclines so that absorption shaft 51a and 51b, and the angle of 45 degrees may be made by field inboard, and carries out orientation to an abbreviation horizontal to the front face of substrate 31a and 31b. Consequently, the liquid crystal layer 32 has strong form birefringence, and the pixel concerned becomes a white display.

[0030] Moreover, when the voltage of middle gradation is impressed, since the liquid crystal molecule of the pixel concerned does not become level to substrate 31a and 31b, if the user (observer) of a liquid crystal display 1 sees from [of a liquid crystal molecule] a major axis, it will be visible [a molecule / user] to a black display. However, with this operation gestalt, since orientation division of the 1 pixel is carried out at plurality (this example four) corresponding to each slant face, the transmitted light from the portion in which the liquid crystal molecule is carrying out orientation in other directions among the pixels concerned is told to the user of the above-mentioned direction. Consequently,

compared with the case where orientation division has not been carried out, middle gradation is more discriminable from a latus viewing angle.

[0031] here -- the display grace from a slanting viewing angle -- the total of the retardation of the above-mentioned both phase contrast film 7a and 7b -- in order to realize the liquid crystal display 1 which had good display grace since it changed sharply according to Rth and the retardation Rlc of a liquid crystal cell 3, it is necessary to select these values to a suitable value However, supposing it sets up retardation at random and repeats experiment/display grace evaluation in arbitrary directions in order to derive a suitable combination as mentioned above, it will take very big time and effort.

[0032] With this operation gestalt, the numerical range from which high contrast is especially acquired at the time of a slanting viewing angle was found out, without applying big time and effort by determining the white voltage Vw and judging whether display grace fulfills desired conditions based on the voltage-permeability curve Ta in the direction A determined from the structure and the angle of visibility alpha of a liquid crystal display 1.

[0033] Here, with this operation gestalt, the property of a liquid crystal display 1 is searched for in the simulation, and each following step is carried out with the arithmetic unit (retardation selecting arrangement) 101 shown in drawing 3 . The simulation processing section 102 which derives the permeability in the arbitrary angles of the liquid crystal display 1 with which the specified voltage was impressed to the arithmetic unit 101 concerned by the simulation, The parameter storage section 103 which memorizes a parameter required for a simulation, The conditioning section 104 which sets up the conditions of requests, such as an angle of visibility alpha and contrast, (condition selection means), The retardation setting section 105 which chooses Retardation Rth and Rlc, The applied-voltage determination section 106 which derives the white voltage and black voltage of the range in which the liquid crystal display 1 which controls the above-mentioned simulation processing section 102, and has above-mentioned retardation Rth-Rlc does not carry out tone reversal within the desired angle of visibility alpha (applied-voltage determination means), The evaluation section (judgment means) 107 which evaluates the contrast of the liquid crystal display 1 with which the above-mentioned simulation processing section 102 is controlled, and the voltage concerned is impressed is formed. In addition, the above-mentioned each part material 102-107 is functional block realized because operation part, such as CPU, performs the program stored in the storage sections, such as ROM and RAM. The computer concerned can operate as an arithmetic unit 101 by the computer which has operation part and the storage section reading from the record medium which recorded the above-mentioned program, or transmitting through a channel, and acquiring and executing the above-mentioned program.

[0034] In the arithmetic unit 101 of the above-mentioned composition, the parameter for deriving the permeability of the liquid crystal display 1 in the arbitrary direction when arbitrary voltage impresses based on directions of a user etc. is set as the parameter storage section 103 in Step 1 (below, it calls for short like S1) shown in drawing 4 . An elastic coefficient, a dielectric constant, a refractive index, a helical pitch, etc. are contained in the parameter concerned as a parameter of liquid crystal. Moreover, for example, cell **, achoring energy, a pre tilt angle, the parameter that shows the cellular structure are contained in the above-mentioned parameter as a parameter of a liquid crystal cell 3. If a parameter is set up by the above S1, in S2, based on the above-mentioned parameter, the simulation processing section 102 of an arithmetic unit 101 will calculate the equilibrium in each voltage, and will calculate the orientation state of the liquid crystal molecule in each voltage.

[0035] on the other hand -- the conditioning section 104 -- S3 -- setting -- for example, directions of a user etc. -- being based -- the desired angle of visibility alpha (for example, 60 degrees) and the minimum -- required contrast (for example, 5) is inputted Furthermore, in S4, the retardation setting section 105 sets up the initial value (for example, 10nm) of the retardation Rth of phase contrast film 7a and 7b based on an index ellipsoid, film **, etc. which form for example, phase contrast film 7a and 7b. Specifically, since it is set as n1=n2>n3 when phase contrast film 7a and 7b are negative films, sets the refractive index within a field to n1 and n2 and the refractive index of the direction of a normal is set to n3 The retardation Rth of phase contrast film 7a and 7b should be shown in the following formulas (1).

Rth=dth- {(n1+n2)/2-n3}

= dth- (n1-n3) -- (1)

It becomes. In addition, in an upper formula (1), dth is the sum total of film ** of phase contrast film 7a and 7b. On the other hand, the retardation Rlc of a liquid crystal cell 3 should be shown in the following formulas (2). Rlc=dlc-deltan -- (2)

It comes out, and it is and the initial value (for example, 10nm) of Retardation Rlc is drawn based on rate of birefringence deltan, the cell thick dlc of the liquid crystal cell 3 set up by the above S1, and rate of birefringence deltan. In addition, as long as it is a setting possible value as retardation Rlc and Rth, Retardation Rlc and Rth may be set up first and thickness dlc and dth may be counted backward based on the above-mentioned formula (1) and a formula (2).

[0036] If the initial value of Retardation Rlc and Rth is set up in the above S1 and S4, it will set to S5. the applied-voltage determination section 106 As a direction (direction A) where display grace is the worst, the direction of the maximum viewing angle (the angle with the direction of a normal of the front face of for example, substrate 31a and 31b to make is 60 degrees) determined as absorption shaft 51a and 51of polarizing-element 5a and 5b b by nothing and the above S3 in 45 degrees by field inboard is chosen. Furthermore, as the simulation processing section 102 is controlled and it is shown in a dashed line among drawing 5 , the applied-voltage determination section 106 draws the voltage-permeability curve Ta in the direction A concerned, and sets up the voltage from which permeability serves as the maximum (Xw point) as white voltage Vw. Moreover, the voltage used as the minimum of permeability is set up as black voltage Vb.

[0037] Here, the above-mentioned directions A are the above-mentioned absorption shaft 51a and 51b, and an angle which makes 45 degrees in a field, and are most distant from the normal in the angle of visibility alpha set up by the above S3. Consequently, as shown in drawing 5 , the voltage-permeability curve Tf and field inboard of the direction of a transverse plane are parallel to absorption shaft 51a and 51b, compared with the voltage-permeability curve Tb in the direction B of the maximum viewing angle, display grace is bad, not only the change range of permeability is narrow, but the maximal value of permeability exists and the range in which permeability carries out a monotonous increase is narrow. Therefore, if it sets up so that the voltage temporarily beyond the voltage used as the above-mentioned maximal value may also be impressed, in the above-mentioned direction A, tone reversal will occur and the part which other directions and light and darkness reverse will appear in a display image. In addition, in this drawing, the value which makes the permeability of air 1 time shows permeability. Moreover, the unit of voltage is [V].

[0038] However, in the above S5, the highest voltage is set up as white voltage (Vw) in Direction A among the ranges in which permeability carries out a monotonous increase. As a result, for example, predetermined voltage, it can determine as white voltage, or compared with the case where white voltage is determined based on the permeability of other directions etc., by fewer computational complexity, it is the highest in the range which does not carry out tone reversal within the angle of visibility alpha set up by the above S3, and white voltage can be set up.

[0039] It judges whether when the white voltage Vw and the black voltage Vb were determined, the evaluation section 107 controlled the simulation processing section 102 by the above S5, it estimated the display grace of the liquid crystal display 1 when the voltage concerned is impressed in S6, and the good viewing-angle property was acquired in S7 by it.

[0040] With this operation gestalt, whether the minimum value of contrast is beyond a value (for example, 5) set up beforehand is estimating the display grace of a liquid crystal display 1, and as the minimum value of contrast, in the above-mentioned direction A, the evaluation section 107 computes the ratio of the permeability Taw at the time of white voltage Vw impression, and the permeability Tab at the time of black voltage Vb impression, and evaluates display grace by whether the value concerned is more than the above-mentioned set point. In addition, since both the permeability Taw and Tab is drawn in case it derives the voltage-permeability curve Ta in the above-mentioned S4, it can compute the minimum value of contrast by few computational complexity.

[0041] Since the combination of Retardation Rlc and Rth is suitable when a good viewing-angle property is acquired by the judgment of the above S7, an arithmetic unit 101 completes optimization. On the other hand, when a good viewing-angle property is not acquired (in the case [Above S7,] of NO), in S8, the evaluation section 107 is the retardation Rlc of the liquid crystal cell 3 set up now, based on the change history of the display grace when changing Retardation Rth until now, if retardation Rth is enlarged further, will presume whether a property gets worse, and judges whether it is necessary to change the above-mentioned retardation Rlc. For example, when the present retardation Rth is judged to be the maximum from the history of change of the above-mentioned display grace, in S9, the evaluation section 107 changes the value of the parameter storage section 103, changes cell ** and the refractive index of a liquid crystal cell 3, and changes 10 etc.nm of retardation Rlc of a liquid crystal cell 3 etc. at a time by predetermined value serration. After that, the processing after the above S2 is repeated. On the other hand, even if it makes Retardation Rth increase, when it is presumed that display grace does not fall (in the case [Above S8,] of NO), the evaluation section 107 repeats the above-mentioned S4 or subsequent ones, and the retardation setting section 105 makes the retardation Rth of phase contrast film 7a and 7b, such as every 10 etc.nm, increase by predetermined value serration, and it reevaluates display grace.

[0042] With the above-mentioned composition, white and black voltage are determined based on the voltage-permeability curve Ta in the specific direction A determined as absorption shaft 51a and 51of polarizing-element 5a and 5b b with the desired angle of visibility alpha. As a result, for example, predetermined voltage, it can determine as white voltage, or compared with the case where white voltage is determined based on the permeability of other directions etc., by fewer computational complexity, it is the highest in the range which does not carry out tone reversal within the above-mentioned angle of visibility alpha, and white voltage can be set up. Therefore, by the fewer effort,

tone reversal is not carried out within the desired angle of visibility alpha, but the liquid crystal display 1 with the moreover highest (the brightest) permeability can be manufactured.
[0043] In addition, although reference is closed in the flow chart of drawing 4 when a good viewing-angle property is acquired, after a good viewing-angle property is acquired, Retardation Rlc and Rth is changed, and if the range from which a good viewing-angle property is acquired is computed, it will become like drawing 6 and drawing 7 . Even in this case, in each combination of Retardation Rlc and Rth, since a viewing-angle property is judged where white voltage is set up so that it may become the brightest in the range which does not carry out gradation within an angle of visibility alpha, the experiment and computational complexity for every combination are reducible.
[0044] Here, it is a high line that each line of drawing 6 shows the range of the retardation Rlc and Rth which can attain the minimum contrast in each at the time of changing the minimum contrast set up as conditions by 2.5 serration to 2.5-12.5 by the above S3 etc. As a value which does not have a problem in practical use in any way among the above, if contrast 5 is chosen, it will become the range of drawing 7 . If this drawing is examined in detail, in order not to carry out tone reversal in the range to 60 viewing angles but to maintain contrast 5 at least by the within the limits concerned moreover, the sum total Rth of the retardation Rlc of a liquid crystal cell 3 and the retardation of phase contrast film 7a and 7b should be shown below. Rth <= Rlc + 150nm -- (3)
Rth >= 1.25, Rlc - 262.5nm -- (4)
Rlc >= 75nm -- (5)
Rth >= 30nm -- (6)
It turns out that it is necessary to carry out ** satisfactory.
[0045] Therefore, if a liquid crystal cell 3 and the retardation Rlc and Rth of phase contrast film 7a and 7b are set up so that the above-mentioned formula (3) - a formula (6) may be satisfied in case a liquid crystal display 1 is manufactured, also in a slanting viewing angle, good contrast is securable.
[0046] At [the 2nd operation gestalt] and time, the display grace of a liquid crystal display was judged with the 1st operation gestalt by whether the contrast of the request by desired angle-of-visibility alpha within the limits is maintainable. On the other hand, this operation gestalt explains the case where display grace is judged, based on the permeability at the time of the white voltage of the direction of a transverse plane which influences the brightness and contrast of the direction of a transverse plane of a liquid crystal display.
[0047] That is, with this operation gestalt, as shown in drawing 8 , in S21 replaced with and prepared in S3 shown in drawing 4 , the conditioning section 104 sets up the permeability (for example, 0.2 times when making the permeability of air into 1 time etc.) of the direction of a transverse plane as conditions for a good viewing-angle property. Moreover, in S22 replaced with and prepared in S6, the evaluation section 107 controls the simulation processing section 102, draws the permeability Tfw of the direction of a transverse plane at the time of impressing the white voltage Vw determined by the above S5, and evaluates whether it is beyond the value to which the permeability Tfw concerned was set by the above S21. For example, in the example shown in drawing 9 , the permeability Tfw of the direction of a transverse plane is about 0.4001, and the white voltage Vw determined by the above S5 shows fulfilling the above-mentioned conditions. In addition, the above-mentioned permeability is the value which made the permeability of air 1 time. Moreover, based on the voltage-permeability curve Ta of Direction A, the white voltage Vw is determined by this case as well as the 1st operation gestalt. Therefore, the parameter of a liquid crystal display 1 can be set up so that tone reversal may not be carried out within the desired angle of visibility alpha but permeability may moreover become high (bright) most by the fewer effort.
[0048] Here, like drawing 6 and drawing 7 , after a good viewing-angle property is acquired, Retardation Rlc and Rth is changed, and if the range from which a good viewing-angle property is acquired is computed, it will become like drawing 10 and drawing 11 . In drawing 10 , it is a high line that each line shows the range of the retardation Rlc and Rth which can attain the permeability concerned in each at the time of changing the permeability Tfw at the time of the white voltage of the direction of a transverse plane set up as conditions by the above S21 to 0.05 serration to 0.05-0.45 etc. As a value which does not have a problem in practical use in any way among the above, if permeability Tfw=0.2 at the time of the white voltage of the direction of a transverse plane are chosen, it will become the range of drawing 11 . If this drawing is examined in detail, tone reversal is not carried out in the range to 60 viewing angles, but in order to make the permeability Tfw at the time of the white voltage of the direction of a transverse plane or more into 0.2, moreover, the sum total Rth of the retardation Rlc of a liquid crystal cell 3 and the retardation of phase contrast film 7a and 7b should be shown below. Rth <= 1.5, Rlc + 80nm -- (7)
Rlc >= 155nm -- (8)
It turns out that it is necessary to carry out ** satisfactory.
[0049] Therefore, if a liquid crystal cell 3 and the retardation Rlc and Rth of phase contrast film 7a and 7b are set up so that an above-mentioned formula (7) and an above-mentioned formula (8) may be satisfied in case a liquid crystal

display 1 is manufactured, the tone reversal of a slanting viewing angle can be suppressed, without spoiling front brightness and front contrast.

[0050] It is more desirable to keep the ratio of the brightness of each gradation the same mutually irrespective of a televiewer's viewing angle, when a liquid crystal display 1 indicates by gradation in time with [the 3rd operation gestalt]. This operation gestalt explains the case where display grace is judged by desired angle-of-visibility within the limits based on whether the ratio of the permeability Tan of the direction A in each gradation n and the permeability Tfn of the direction of a transverse plane is predetermined within the limits as an error criterion of further others in order to secure good display grace also at the time of a gradation display.

[0051] That is, with this operation gestalt, as shown in drawing 12 , in S31 replaced with and prepared in S3 shown in drawing 4 , the conditioning section 104 sets up the ratio which the permeability Tan of the direction A in each gradation n and the permeability Tfn of the direction of a transverse plane should satisfy as conditions for a good viewing-angle property. In addition, although the ratio itself may be set up, with this operation gestalt, the range of the permeability Tan in Direction A is set up. Specifically, in the case of eight gradation (i.e., black), it is the 0th gradation, and if the permeability Tfw at the time of the white voltage in the direction of a transverse plane is normalized as 100% when white is the 7th gradation, the permeability Tf6 of the 6th gradation in the direction of a transverse plane will become 6/7, i.e., about 85.7%. In this case, as conditions for a good viewing-angle property, the permeability Ta 6 of the 6th gradation in Direction A makes 100% the permeability Taw at the time of the white voltage in Direction A, for example, is set as 80% - 95% of range.

[0052] Moreover, with this operation gestalt, after setting up the white voltage Vw and the black voltage Vb in above-mentioned S5, in S32, the applied-voltage determination section 106 controls the simulation processing section 102, and computes the permeability Tfn of the direction of a transverse plane in each gradation based on the permeability Tfw of the direction of a transverse plane in the white voltage Vw, and the permeability Tfb of the direction of a transverse plane in the black voltage Vb. Furthermore, the applied voltage used as each permeability Tfn is determined for every gradation from the voltage-permeability curve Tf of the direction of a transverse plane. As mentioned above, if the case of eight gradation is made into an example, since the permeability Tf6 of the 6th gradation in the direction of a transverse plane turns into about 85.7% of the permeability Tfw at the time of white voltage, in the voltage-permeability curve Tf top of the direction of a transverse plane shown in drawing 13 , the voltage V6 corresponding to the point X6 of permeability Tf6 will be set up as applied voltage V6 of the 6th gradation.

[0053] Furthermore, if the applied voltage of each gradation is determined, in S33 replaced with and prepared in S6, the evaluation section 107 will control the simulation processing section 102, will draw the permeability Tan of the direction A in each applied voltage determined by the above S32, and will judge whether it is within the limits to which the permeability Tan concerned was set by the above S31. In addition, based on the voltage-permeability curve Ta of Direction A, the white voltage Vw is determined by this case as well as the 1st operation gestalt. Therefore, by the fewer effort, tone reversal is not carried out within the desired angle of visibility alpha, but moreover, the parameter of a liquid crystal display 1 can be set up so that it may become the gradation which was similar with the gradation of the direction of a transverse plane within the angle of visibility alpha concerned also in the direction where display grace is the worst.

[0054] Here, like drawing 6 and drawing 7 , after a good viewing-angle property is acquired, Retardation Rlc and Rth is changed, and if the range from which a good viewing-angle property is acquired is computed, it will become like drawing 14 and drawing 15 . In drawing 14 , it is a high line that the range of the retardation Rlc and Rth from which the permeability Ta 6 in the direction A of [at the time of applying the applied voltage V6 of the 6th gradation] becomes a predetermined value is shown etc., and each line is a contour line of 0.75% serration from 57.5% to 95%, when the permeability Taw at the time of the white voltage impression in Direction A is made into 100%. As a value which does not have a problem in practical use in any way among the above, if 95 to 80% of range is chosen by the case of the 6th gradation, it will become the range of drawing 15 . If this drawing is examined in detail, tone reversal is not carried out in the range to 60 viewing angles, but in order to make the gradation property in Direction A into the property of the direction of a transverse plane in general at an analog, moreover, the sum total Rth of the retardation Rlc of a liquid crystal cell 3 and the retardation of phase contrast film 7a and 7b should be shown below. Rth <= 250nm -- (9)

Rlc >= 30nm -- (10)

It turns out that it is necessary to carry out ** satisfactory.

[0055] Therefore, if a liquid crystal cell 3 and the retardation Rlc and Rth of phase contrast film 7a and 7b are set up so that an above-mentioned formula (9) and an above-mentioned formula (10) may be satisfied, within the limits of the desired angle of visibility alpha, tone reversal is not carried out but, moreover, the liquid crystal display 1 in which the gradation property and analogous property of the direction of a transverse plane are shown can be realized.

[0056] [4th operation gestalt] This operation gestalt explains the case where display grace is judged by all the criteria in the above 1st or the 3rd operation gestalt. That is, as shown in drawing 16 , with this operation gestalt, the contrast in Direction A, the luminosity of the direction of a transverse plane, and the relation between the permeability of the direction A in each gradation and the permeability of the direction of a transverse plane are set up as conditions for good display grace in S41 replaced with S3 of drawing 4 .
[0057] Moreover, after the applied voltage of each gradation is determined, by S43 replaced with S6, the contrast in Direction A, the luminosity of the direction of a transverse plane, and the relation between the permeability of the direction A in each gradation and the permeability of the direction of a transverse plane are drawn, and the display grace of a liquid crystal display 1 is judged the S42 [same] as S32 of drawing 12 . In addition, based on the voltage-permeability curve Ta of Direction A, the white voltage Vw is determined by this case as well as the 1st operation gestalt. Therefore, the parameter of a liquid crystal display 1 can be set up so that tone reversal may not be carried out within the desired angle of visibility alpha but it may moreover have the effect of the 1st or 3rd liquid crystal display by the fewer effort.
[0058] The range which the range shown in drawing 7 , the range shown in drawing 11 , and the range shown in drawing 15 overlapped as it changed Retardation Rlc and Rth after a good viewing-angle property is acquired like [here] drawing 7 , and it was shown in drawing 17 , when the range from which a good viewing-angle property is acquired was computed is acquired. therefore, an above-mentioned formula (3) - a formula (10) -- without spoiling the permeability of the direction of a transverse plane, if a liquid crystal cell 3 and the retardation Rlc and Rth of phase contrast film 7a and 7b are set up, so that all may be satisfied, tone reversal is not carried out within the limits of the desired angle of visibility alpha, but the minimum contrast is beyond a predetermined value and, moreover, the liquid crystal display 1 with which the gradation property of the direction of a transverse plane and the arbitrary direction was similar can be realized
[0059] By the way, although the retardation Rlc of a liquid crystal cell 3 was changed and change of the above-mentioned retardation Rth is repeated with the 1st or 4th operation gestalt when display grace gets worse while changing the sum total Rth of the retardation of phase contrast film 7a and 7b from initial value, the selection method of an evaluation point (Retardation Rlc and Rth should put together) is not restricted to this. For example, you may search an optimum value, changing the both sides of both the retardation Rlc and Rth based on an evaluation result, as shown in drawing 18 .
[0060] Specifically, on the two-dimensional map centering on Retardation Rlc and Retardation Rth, at first, three points (Rlc, Rth) are chosen arbitrarily and the display grace of the liquid crystal display 1 in each point is evaluated. For example, S5 and S6 which are shown in drawing 4 are processed for each point, and the example of the 1st operation gestalt estimates the contrast of Direction A.
[0061] Here, when it considers as points C1, C2, and C3 from the order of a low of evaluation among each point, the middle point of a point C2 and a point C3 is computed, and it considers as a point C4. Furthermore, the externally dividing point of 1:2, the middle point, the externally dividing point of 2:1, and the externally dividing point of 3:2 are computed as D1 - a point D4, respectively on the basis of the point C1 describing above and a point C4. Moreover, the display grace of a liquid crystal display 1 is evaluated about each point D1-D4.
[0062] Furthermore, the point E among points D1-D4 that evaluation is the highest is replaced with a point C1, evaluation of Point E, a point C2, and a point C3 is compared, and calculation of a point D1 - a point D4 and evaluation of display grace are repeated as new points C1, C2, and C3 in order of the low of evaluation. In addition, evaluation may not be restricted to the contrast of Direction A etc. and may be synthetically judged based on the comprehensive evaluation value computed by the predetermined performance index from brightness, a gradation property, etc. of the contrast of Direction A, and the direction of a transverse plane.
[0063] Since the white voltage Vw is determined also by the above-mentioned method based on the voltage-permeability curve Ta of Direction A, the retardation Rlc and Rth which fills desired conditions with fewer computational complexity is computable. Furthermore, although the range which fills desired conditions with the method concerned unlike drawing 4 , drawing 8 , drawing 12 , and drawing 16 is uncomputable, since the both sides of both the retardation Rlc and Rth are adjusted according to an evaluation result, it is computational complexity still fewer than each above-mentioned drawing, and the retardation Rlc and Rth for manufacturing the liquid crystal display 1 with the optimal display grace can be computed.
[0064] In [the 5th operation gestalt] and time, with the above 1st or the 4th operation gestalt, when deriving many properties of a liquid crystal display 1, the voltage-permeability curve etc. made the example the case where it computed in a simulation, and explained, for example. On the other hand, with this operation gestalt, an experiment explains the case where many properties are derived.
[0065] That is, in arithmetic unit 101a shown in drawing 19 , it replaces with the simulation processing section 102 and

the parameter storage section 103 which are shown in drawing 3 , for example, the measured-value input section 108 into which a measurement result is inputted is formed from a user, a measuring device, etc. of arithmetic unit 101a, and the applied-voltage determination section 106 and the evaluation section 107 have received the value from the simulation processing section 102, and the same value from the measured-value input section 108. Each retardation Rlc and Rth can be determined by this by the same method as the 1st or 4th operation gestalt, and the same result can be derived. Moreover, since the white voltage Vw is determined based on the voltage-permeability curve Ta of Direction A, the composition concerned can also compute the retardation Rlc and Rth which fills desired conditions with a fewer measurement count.

[0066] By the way, although the case where a negative film was used was made into the example as phase contrast film 7aand7b and the 1st or 5th operation gestalt explained, even when not only this but a right film is used, the combination of the optimal retardation Rlc and Rth can be derived by the same method. If it is a film used as n1>n2=n3 and the retardation Rth considers dth as the sum total of the thickness of both the phase contrast film, when a right film is made into the refractive indexes n1 and n2 within a field, and the refractive index n3 of the direction of a normal Rth=dth- {(n1+n2)/2-n3} -- (11)

It is computed by carrying out.

[0067] Also with this liquid crystal display, by the same method as the 1st or 5th operation gestalt, when the range of the optimal retardation Rlc and Rth was searched for, it was checked that it is the same as that of each range.

[0068] Moreover, phase contrast film 7a and 7b may be phase contrast films expressed by the biaxial index ellipsoid. In addition, the retardation Rth of the film concerned is also computed by the above-mentioned formula (11). Also with this liquid crystal display, the range of the optimal retardation Rlc and Rth could be derived by the same method as the 1st or 5th operation gestalt, and it has checked that it was the same as that of each range.

[0069] Furthermore, although the case where phase contrast film 7a and 7b were allotted to the both sides of a liquid crystal cell 3 was made into the example and each above-mentioned operation gestalt explained, you may allot only one side. Moreover, you may realize phase contrast film 7a (7b) for two or more kinds of phase contrast films in piles. the total of the retardation of the phase contrast film which can derive the optimal range of Retardation Rlc and Rth, and is arranged between both polarizing-elements 5a and 5b by the same method even if it is which case -- it was checked that the optimal range of Rth and the retardation Rlc of a liquid crystal cell 3 is the same as the range which the 1st or 5th operation gestalt shows

[0070] In addition, although the case where a liquid crystal cell 3 was set as the perpendicular orientation mode of quadrisection was made into the example and the salient 34 shown in drawing 2 explained with each above-mentioned operation gestalt, it does not restrict to this. For example, by the shape of L character, as shown in drawing 20 , the configuration within a field may form the salient 36 of a configuration in the pixel electrode 33 similarly at the counterelectrode of CF substrate, while the configuration of the direction of a normal forms the salient 35 of Yamagata. In addition, the interval of both salients 35-36 in the field inboard of substrate 31a and 31b is allotted so that the normal of the slant face of salient 35 and the normal of the slant face of salient 36 may be in agreement. Moreover, like salient 34 etc., each above-mentioned salient 35-36 applies a light-sensitive nature resin on the above-mentioned pixel electrode 33 and a counterelectrode, and can form it by processing it at a photo lithography process.

[0071] Among salients 35, on the other hand, in a portion, if the liquid crystal molecule of the field 37-38 near [concerned] the portion is based on absorption shaft 51a and 51of polarizing-element 5a and 5b of corner of L characters shown in drawing 1 in field inboard of substrate 31a and 31b b, in the above-mentioned structure, it will carry out orientation in the direction of 45 degrees, and the direction of 225 degrees by carrying out orientation along both the slant faces in Yamagata. On the other hand, among salients 35, in the portion of another side of the corner of L characters, the liquid crystal molecule of the field 39-40 near [concerned] the portion carries out orientation along both the slant faces in Yamagata, and in field inboard, if based on absorption shaft 51a and 51b, orientation will be carried out in the direction of 135 degrees and 315 degrees. Thereby, in each pixel, the orientation division of the liquid crystal molecule can be carried out in the four directions like the case of drawing 2 .

[0072] Moreover, it does not restrict to the-four number of orientation division, either, and can apply also to the perpendicular orientation mode which carried out orientation division at plurality. Furthermore, as shown in drawing 21 , in the case of the perpendicular orientation mode which prepared semi-sphere-like salient 34a in the pixel electrode 33, and carried out axial-symmetry orientation to it, you may apply. On the TFT substrate (31a or 31b) which arranged the pixel electrode (33) in the shape of a matrix, salient 34a applies a light-sensitive nature resin, is processing it at a photo lithography process, and can form every one salient 34a for every pixel. Even if it was which case, the optimal range of Retardation Rlc and Rth could be computed by the same method, and it has checked that the same range was the optimal.

[0073] Moreover, when, forming a large-sized liquid crystal television like 40 inches for example, the size of each

pixel becomes large with 1mm grade around, and only by preparing a salient (34and34a) in every one pixel electrode, orientation restraining force becomes weaker and it has a possibility that orientation may become unstable. Therefore, it is more desirable to prepare two or more salients on each pixel electrode 33, when orientation restraining force is insufficient.

[0074]

[Effect of the Invention] For the liquid crystal display concerning this invention, the sum total Rth of the retardation of the thickness direction of a phase contrast film and the retardation Rlc of a liquid crystal layer are Rth<= as mentioned above. Rlc + 150nm, Rth >= 1.25, Rlc - 262.5nm, Rlc >= 75nm and Rth >= It is the composition of filling 30nm.

[0075] With the above-mentioned composition, the upper limit and the minimum are set up about the retardation combination of a liquid crystal layer and a phase contrast film, and five or more contrast can be maintained, without carrying out tone reversal in the viewing-angle range at large [to a direction] which inclined 60 degrees from [of a substrate] the normal, if it is set as the range concerned. Consequently, the effect that the good liquid crystal display of the display grace of a slanting viewing angle is certainly realizable is done so.

[0076] the liquid crystal display concerning this invention -- above -- the above-mentioned composition -- in addition -- further -- the total of the retardation of the thickness direction of the above-mentioned phase contrast film -- Rth and the retardation Rlc of the above-mentioned liquid crystal layer -- Rth <= 1.5 and Rlc + 80nm and Rlc >= It is the composition of filling 155nm.

[0077] According to the composition concerned, the permeability of the direction of a transverse plane of a liquid crystal display can be kept at 0.2 or more times of the permeability of air. Consequently, the display grace of a slanting viewing angle does so the effect that a good liquid crystal display is certainly realizable, without spoiling the brightness of the direction of a transverse plane, and contrast.

[0078] For the liquid crystal display concerning this invention, the sum total Rth of the retardation of the thickness direction of a phase contrast film and the retardation Rlc of a liquid crystal layer are Rth<= as mentioned above. 1.5, Rlc + 80nm and Rlc >= It is the composition of filling 155nm.

[0079] Moreover, the permeability of the direction of a transverse plane can be kept at 0.2 or more times of the permeability of air, without carrying out tone reversal of it in the viewing-angle range at large [to a direction] which inclined 60 degrees from [of a substrate] the normal, if the upper limit and the minimum are set up about the retardation combination of a liquid crystal layer and a phase contrast film and the above-mentioned composition is also set as the range concerned. Consequently, the display grace of a slanting viewing angle does so the effect that a good liquid crystal display is certainly realizable, without spoiling the brightness of the direction of a transverse plane, and contrast.

[0080] The liquid crystal display concerning this invention is set in the above-mentioned composition as mentioned above, and the sum total Rth of the retardation of the thickness direction of the above-mentioned phase contrast film is Rth. <= 250nm and Rlc >= It is the composition of filling 30nm.

[0081] According to the composition concerned, in the viewing-angle range at large [to a direction] which inclined 60 degrees from [of a substrate] the normal, the voltage-permeability property which was similar to the voltage-permeability property in the direction of a transverse plane in general can be maintained. Consequently, even if it sees the picture displayed on a liquid crystal display from which direction of the above-mentioned viewing-angle range, it becomes a value with the in general same ratio of the luminosity between each gradation, and the effect that the gradation property of a slanting viewing angle can realize a good liquid crystal display is done so.

[0082] The liquid crystal display concerning this invention is the composition that two or more fields where the response directions of a liquid crystal molecule differ for every pixel are established in the above-mentioned liquid crystal layer in addition to each above-mentioned composition. Moreover, the liquid crystal display concerning this invention is the composition that the response direction of a liquid crystal molecule is set in general as the axial symmetry for every pixel in the above-mentioned liquid crystal layer in addition to each above-mentioned composition. Furthermore, the liquid crystal display concerning this invention is the composition that two or more shafts of the above-mentioned axial-symmetry orientation are established for every pixel, in the above-mentioned composition. According to these composition, since a mutual field carries out optical compensation and it suits by orientation division of a pixel, the effect that a liquid crystal display with the more good display grace of a slanting viewing angle is realizable is done so.

[0083] The retardation selection method of the liquid crystal display concerning this invention As mentioned above, when the combination of the retardation of a liquid crystal layer and the retardation of a phase contrast film is derived, The voltage-permeability property of the liquid crystal display in the 1st direction in which it inclines most from [of a substrate] a normal among desired angles of visibility, and the direction within a field of a substrate makes the absorption shaft of a polarizing element and the angle of 45 degrees is drawn. It is composition including the applied-

voltage determination process of determining the maximum point as white voltage, and the judgment process which judges whether display grace satisfies desired display grace based on the determined white voltage.

[0084] With the above-mentioned composition, based on a desired angle of visibility and the absorption shaft orientation of a polarizing element, display grace determines the 1st worst direction and determines the maximal value of the voltage-permeability curve of the 1st direction concerned as white voltage. Consequently, tone reversal is not carried out within an angle of visibility, but the effect that the combination of retardation with the moreover highest display grace can be derived by comparatively few time and effort is done so.

[0085] The retardation selection method concerning this invention is the composition of the above-mentioned judgment process comparing the contrast in the 1st direction of the above with the minimum contrast which should be maintained within an angle of visibility, and judging, in the above-mentioned composition as mentioned above.

[0086] According to the composition concerned, the contrast of the 1st direction where display grace is the worst can derive the combination with which desired conditions are filled within the above-mentioned angle of visibility. Therefore, the effect that the retardation combination which can secure the above-mentioned minimum contrast at least can be derived by comparatively few time and effort throughout [above-mentioned] the inside of an angle of visibility is done so.

[0087] The retardation selection method concerning this invention is the composition of setting up the permeability at the time of the white voltage impression in the direction of a transverse plane of the above-mentioned substrate as display grace set up at the above-mentioned conditioning process in each above-mentioned composition as mentioned above. According to the composition concerned, the effect that the retardation combination for the brightness and contrast of the direction of a transverse plane realizing a good liquid crystal display can be derived is done so.

[0088] The retardation selection method concerning this invention is set in each above-mentioned composition as mentioned above. furthermore, based on the above-mentioned white voltage and the voltage-permeability property in the direction of a transverse plane of the above-mentioned substrate, as display grace set up at the above-mentioned conditioning process including the middle gradation voltage determination process of determining the applied voltage of middle gradation It is the composition of setting up the grade of similarity in each gradation voltage-permeability property in the above-mentioned transverse-plane direction, and each gradation voltage-permeability property in the 1st direction of the above.

[0089] With the above-mentioned composition, after determining middle gradation voltage based on the white voltage decided at the above-mentioned applied-voltage determination process, a similar grade is judged about the gradation voltage-permeability property of the 1st direction and the direction of a transverse plane. Consequently, even if it is the case where the picture displayed on a liquid crystal display is seen from which direction of [in the above-mentioned angle of visibility], the effect that retardation combination to which the ratio of the luminosity between each gradation is similar can be derived by comparatively few time and effort is done so.

[0090] The retardation selecting arrangement of the liquid crystal display concerning this invention As mentioned above, when the combination of the retardation of a liquid crystal layer and the retardation of a phase contrast film is derived, The voltage-permeability property of the liquid crystal display in the 1st direction in which it inclines most from [of a substrate] a normal among desired angles of visibility, and the direction within a field of a substrate makes the absorption shaft of a polarizing element and the angle of 45 degrees is drawn. It is composition equipped with an applied-voltage determination means to determine the maximum point as white voltage, and a judgment means to judge whether display grace satisfies desired display grace based on the determined white voltage.

[0091] Since the retardation selecting arrangement of the composition concerned derives the combination of the retardation of a liquid crystal layer, and the retardation of a phase contrast film by the above-mentioned retardation selection method, tone reversal of it is not carried out within an angle of visibility, but it does so the effect that the combination of retardation with the moreover highest display grace can be derived by comparatively few time and effort.

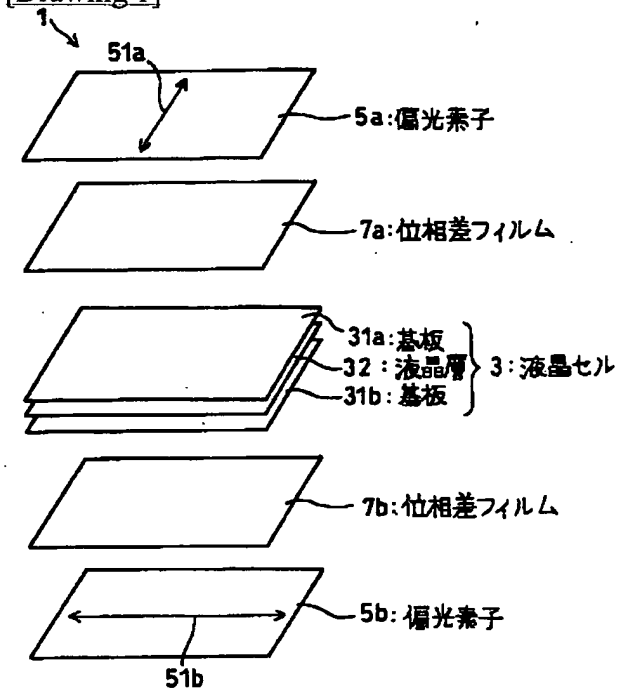
[Translation done.]

* NOTICES *

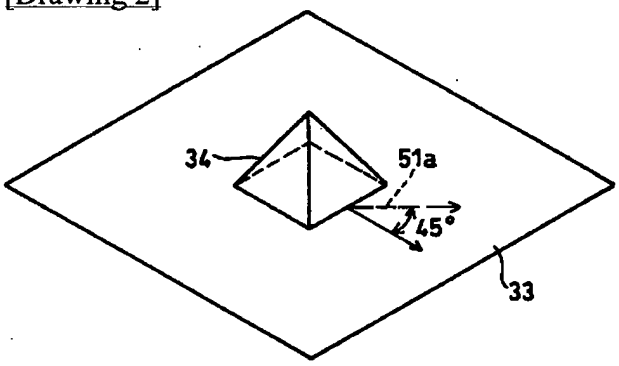
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

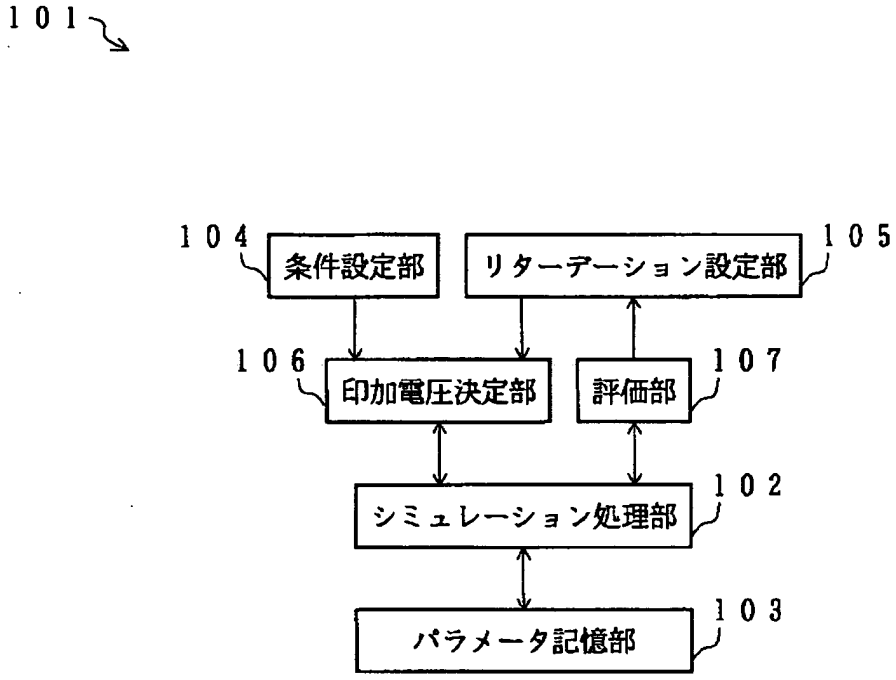
[Drawing 1]



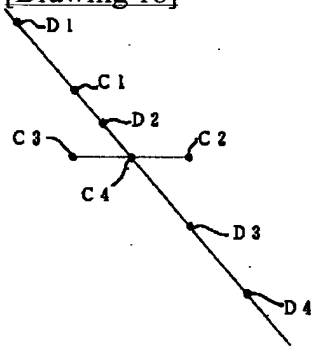
[Drawing 2]



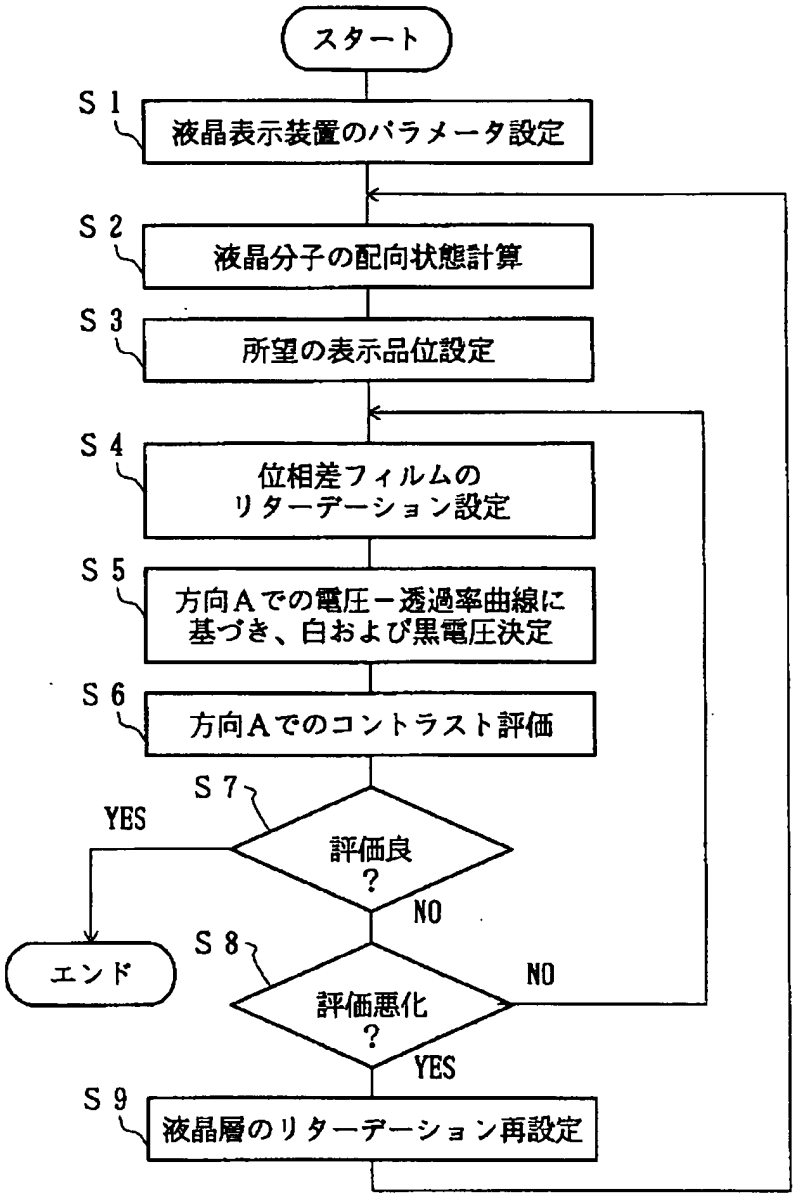
[Drawing 3]



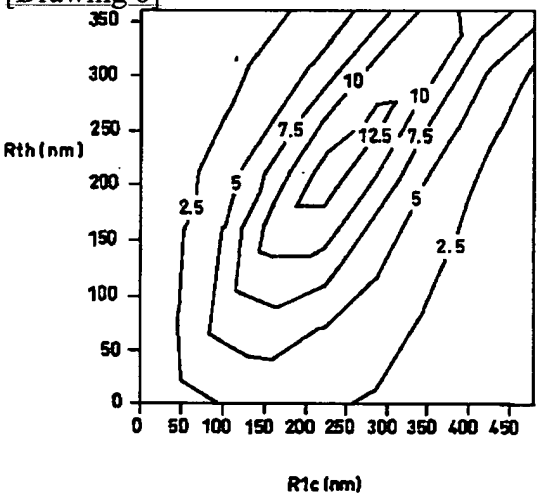
[Drawing 18]



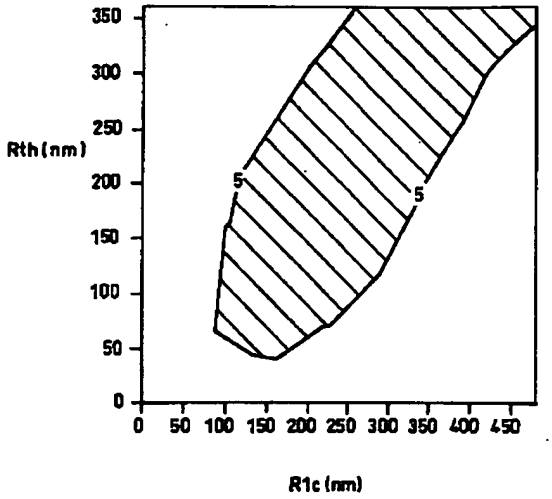
[Drawing 4]



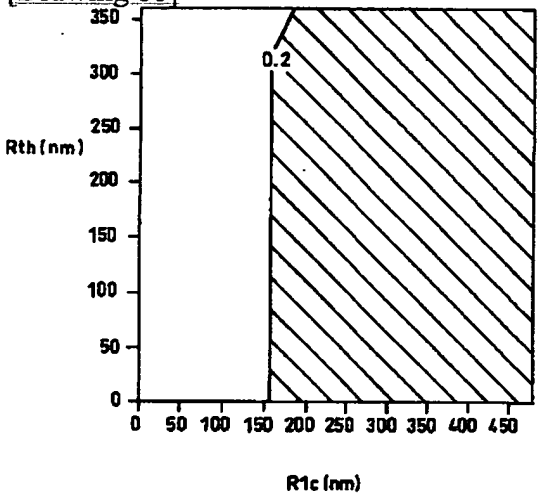
[Drawing 6]



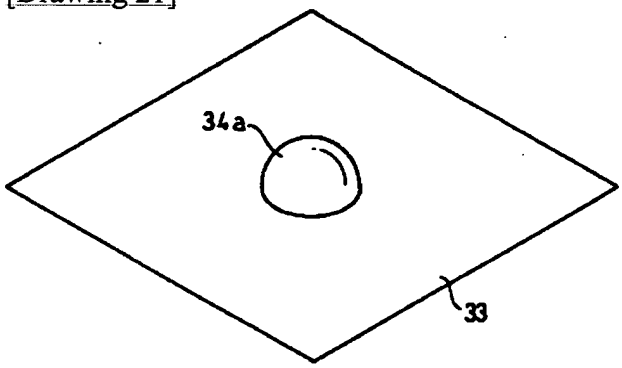
[Drawing 7]



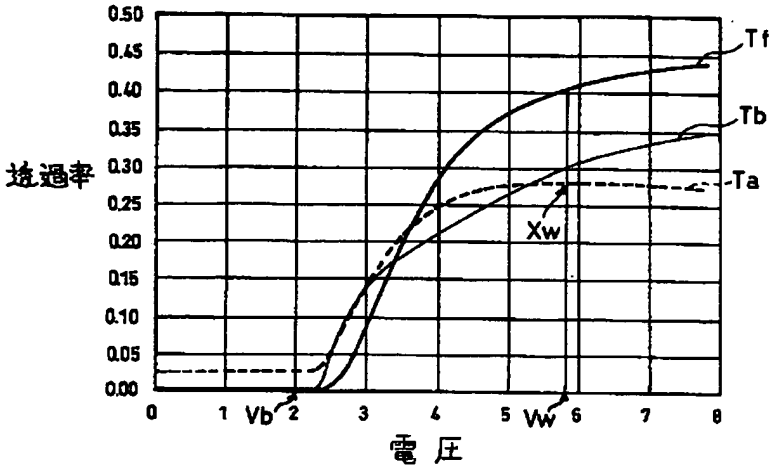
[Drawing 11]



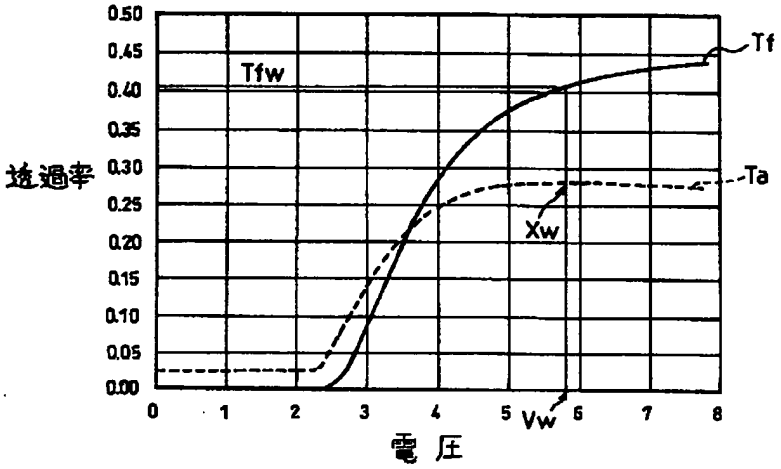
[Drawing 21]



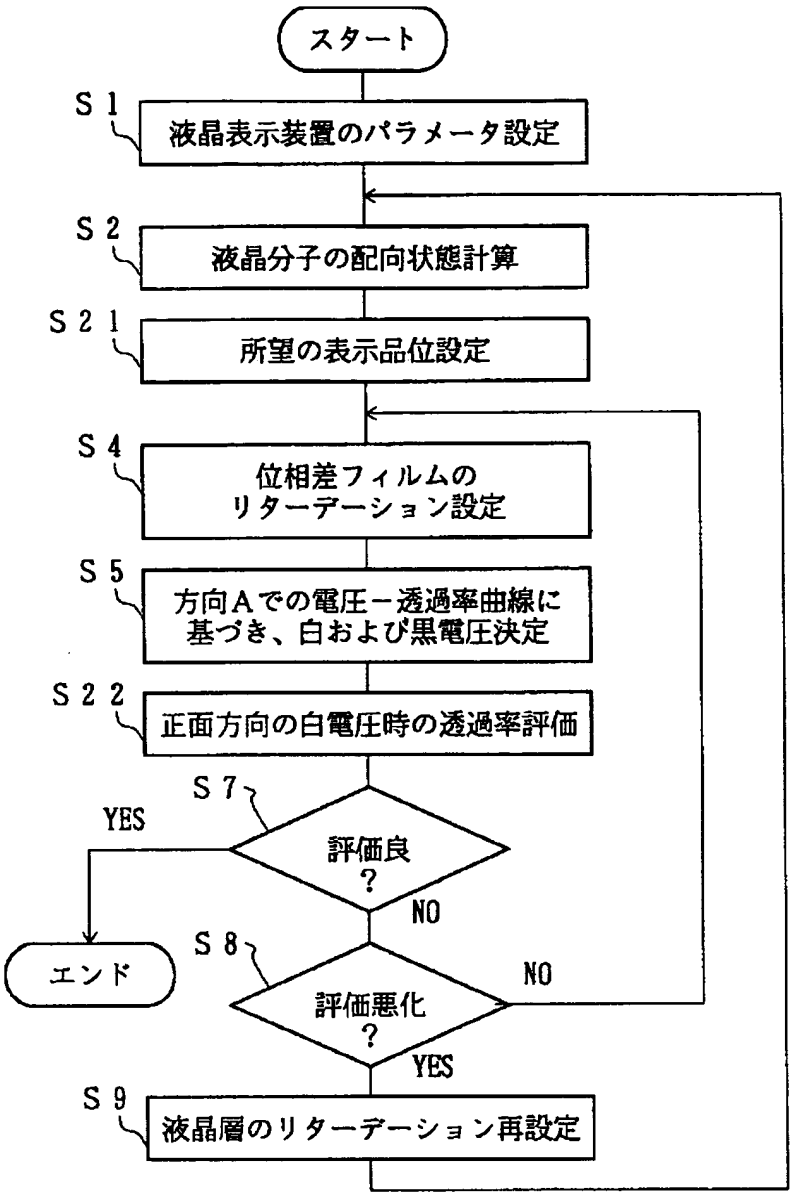
[Drawing 5]



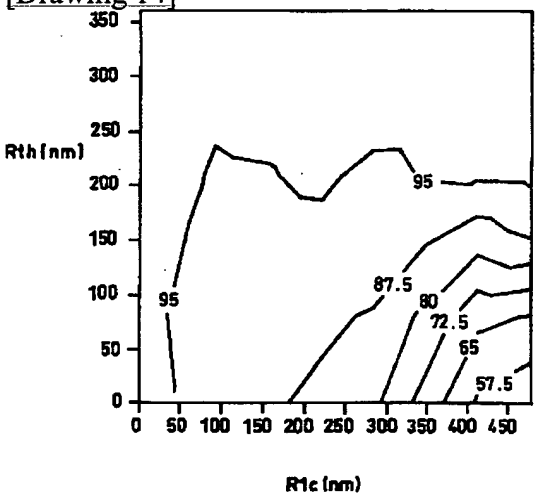
[Drawing 9]



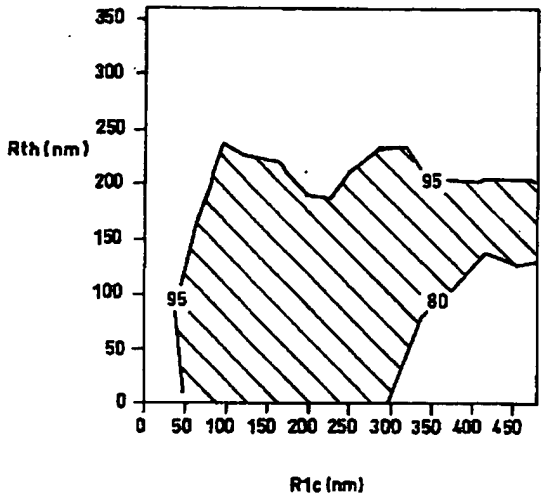
[Drawing 8]



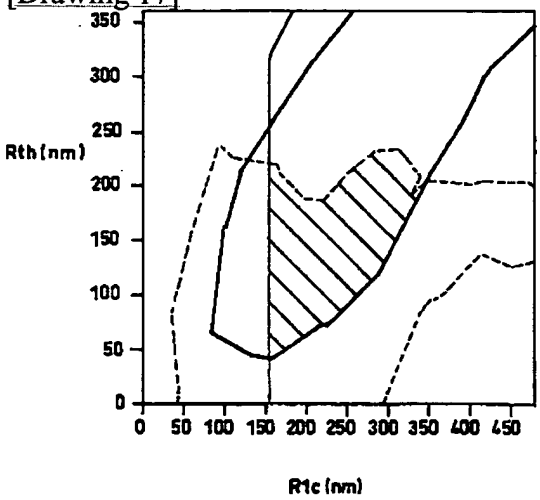
[Drawing 14]



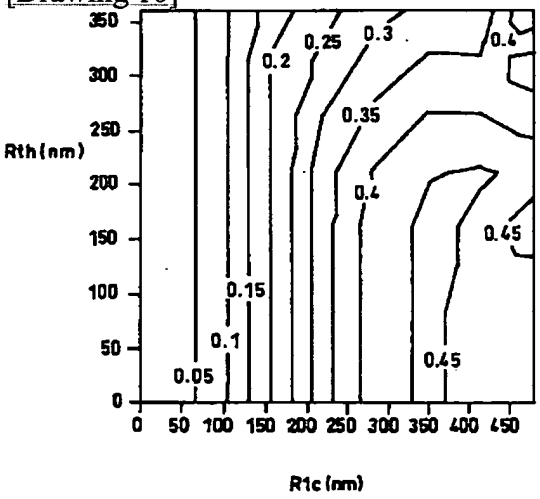
[Drawing 15]



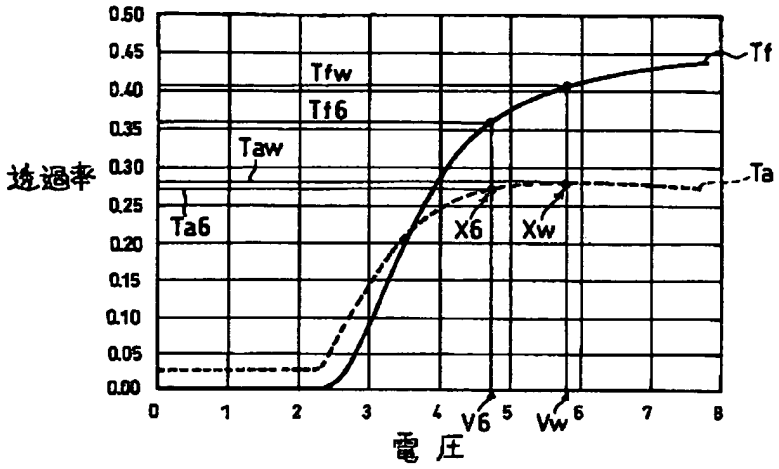
[Drawing 17]



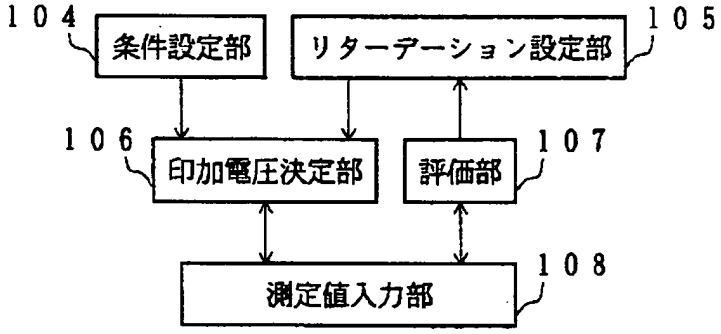
[Drawing 10]



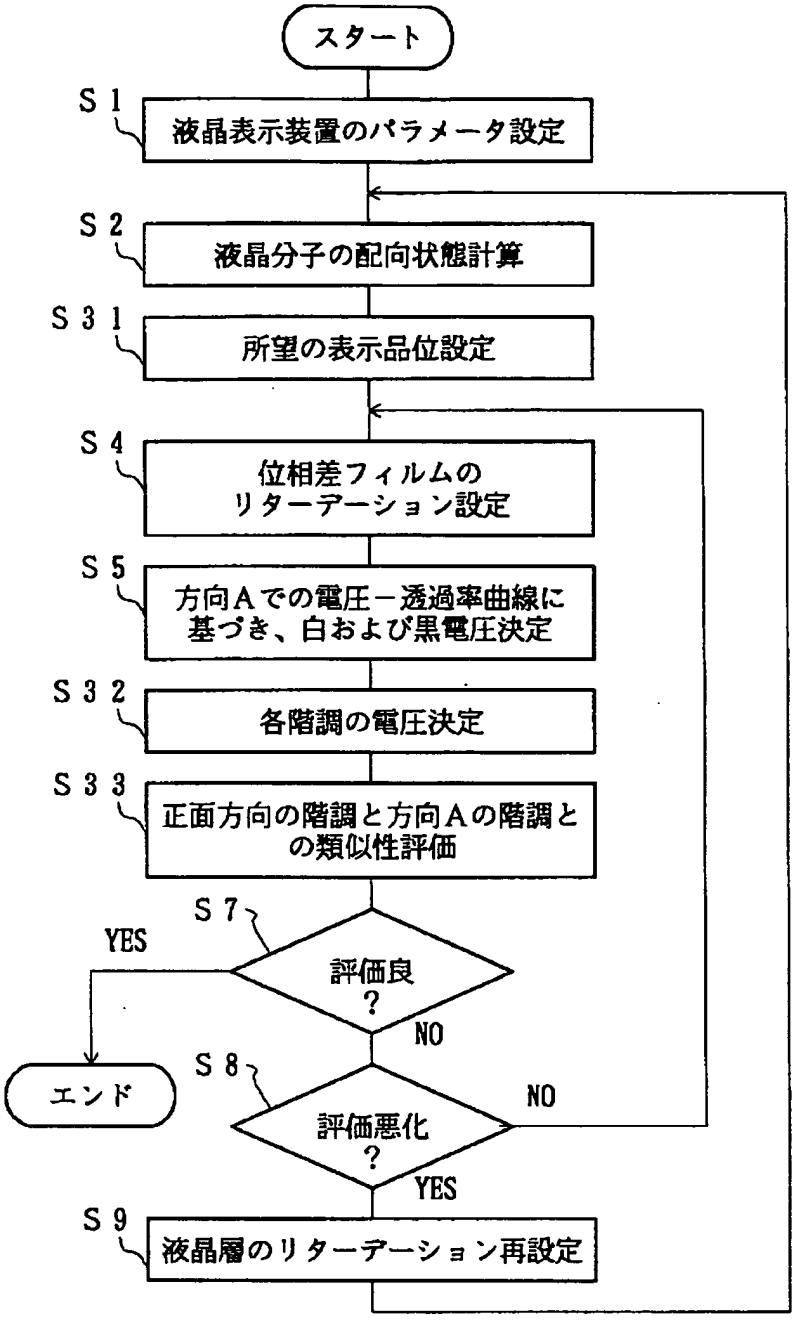
[Drawing 13]



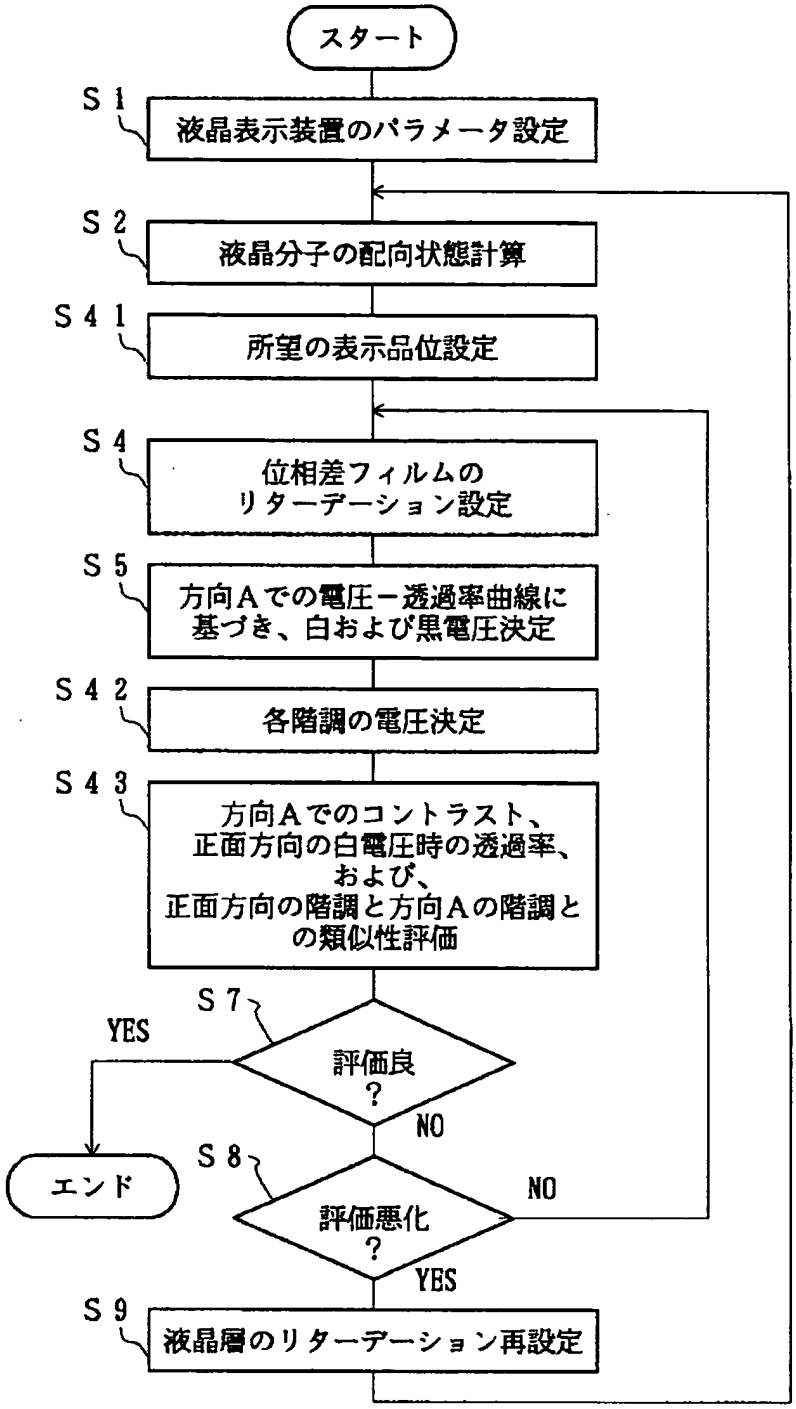
[Drawing 19]



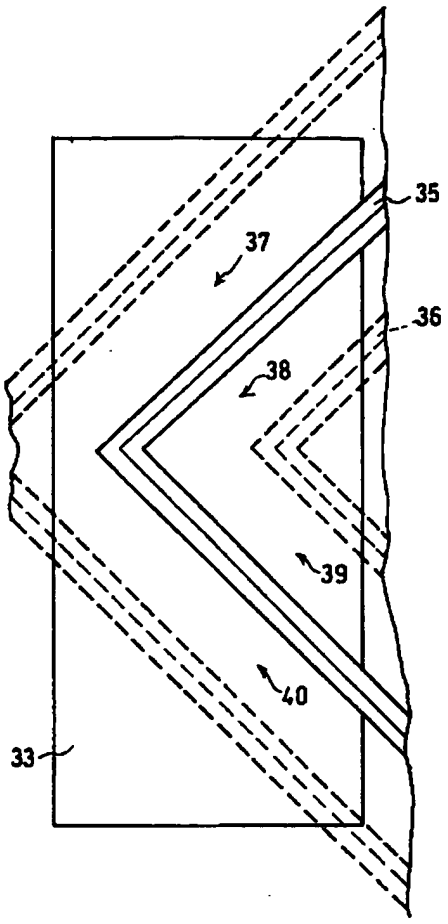
[Drawing 12]


スタート
S 1
液晶表示装置のパラメータ設定
S 2
液晶分子の配向状態計算
S 3 1
所望の表示品位設定
S 4
位相差フィルムの
リターデーション設定
S 5
方向Aでの電圧－透過率曲線に
基づき、白および黒電圧決定
S 3 2
各階調の電圧決定
S 3 3
正面方向の階調と方向Aの階調と
の類似性評価
S 7
評価良
?
YES
NO
エンド
S 8
評価悪化
?
NO
YES
S 9
液晶層のリターデーション再設定

[Drawing 16]


スタート
S 1
液晶表示装置のパラメータ設定
S 2
液晶分子の配向状態計算
S 4 1
所望の表示品位設定
S 4
位相差フィルムの
リターデーション設定
S 5
方向Aでの電圧－透過率曲線に
基づき、白および黒電圧決定
S 4 2
各階調の電圧決定
S 4 3
方向Aでのコントラスト、
正面方向の白電圧時の透過率、
および、
正面方向の階調と方向Aの階調と
の類似性評価
S 7
評価良
？
YES
NO
エンド
S 8
評価悪化
？
NO
YES
S 9
液晶層のリターデーション再設定

[Drawing 20]



[Translation done.]